CLAIMS

What is claimed as new and desired to be protected by Letters Patent of the United States is:

1. A memory element comprising:

a first metal-containing chalcogenide glass layer, said first metal-containing chalcogenide glass layer having a first stoichiometry; and

a second metal-containing chalcogenide glass layer formed over said first metal-containing chalcogenide glass layer, said second metal-containing chalcogenide glass layer having a second stoichiometry different from said first stoichiometry.

2. A memory element of claim 1 wherein said first metal-containing chalcogenide glass layer comprises a first metal-containing germanium-selenide glass layer and said second metal-containing chalcogenide glass layer comprises a second metal-containing germanium-selenide glass layer.

3. A memory element of claim 2 wherein said first metal-containing germanium-selenide glass layer comprises a first silver-containing germanium-selenide glass layer and said second metal-containing germanium-selenide glass layer comprises a second silver-containing germanium-selenide glass layer.

4. A memory element of claim 3 wherein said first and said second silver-containing germanium-selenide glass layers have different stoichiometric compositions represented by $(Ge_xSe_{100-x})_{1-y}Ag_y$.

5. A memory element of claim 4 wherein the value of x for said first silver-containing germanium-selenide glass layer is greater than the

value of x for said second silver-containing germanium-selenide glass layer.

6. A memory element of claim 5 wherein said value of x for said first silver-containing germanium-selenide glass layer is about 38 to about 43 and said value of x for said second silver-containing germanium-selenide glass layer is about 18 to about 33.

7. A memory element of claim 6 wherein said value of x for said first silver-containing germanium-selenide glass layer is about 40 and said value of x for said second silver-containing germanium-selenide glass layer is about 25.

8. A memory element of claim 4 wherein the value of x for said first silver-containing germanium-selenide glass layer is less than the value of x for said second germanium-selenide glass layer.

9. A memory element of claim 1 further comprising first and second electrodes respectively coupled to said first and said second metal-containing chalcogenide glass layers wherein first electrode comprises tungsten and said second electrode comprises silver.

10. A memory element comprising:

a first electrode comprising tungsten;

an insulating layer having an opening in communication with said first electrode;

a first silver-containing germanium-selenide glass layer formed within said opening and in communication with said first electrode, wherein said first silver-containing germanium-selenide glass layer has a stoichiometric composition represented by the formula Ge_xSe_{100-x} and x has a value of about 40;

a second silver-containing germanium-selenide glass layer formed within said opening and in communication with said first silver-containing germanium-selenide glass layer, wherein said second silver-containing germanium-selenide glass layer has a stoichiometric composition represented by the formula Ge_xSe_{100-x} and x has a value of about 25;

a second electrode comprising silver.

11. A memory element comprising:

a first metal-containing chalcogenide glass layer formed within said opening and in communication with said first electrode, wherein said first metal-containing chalcogenide glass layer has a first glass matrix structure;

a second metal-containing chalcogenide glass layer formed within said opening and in communication with said first metal-containing chalcogenide glass layer, wherein said second metal-containing chalcogenide glass layer has a second glass matrix structure different from said first glass matrix structure; and

at least one additional metal-containing chalcogenide glass layer formed within said opening, said at least one additional metal-containing chalcogenide glass layer having a glass matrix structure different from the glass matrix structure of any metal-containing chalcogenide glass layer adjacent to said at least one additional metal-containing chalcogenide glass layer.

12. A memory element of claim 11 wherein:

said first metal-containing chalcogenide glass layer comprises a first metal-containing germanium-selenide glass layer;

said second metal-containing chalcogenide glass layer comprises a second metal-containing germanium-selenide glass layer; and

said at least one additional metal-containing chalcogenide glass layer comprises at least one additional metal-containing germanium-selenide glass layer.

13. A memory element of claim 12 wherein:

said first metal-containing germanium-selenide glass layer comprises a first silver-containing germanium-selenide glass layer;

said second metal-containing germanium-selenide glass layer comprises a second silver-containing germanium-selenide glass layer; and

said at least one additional metal-containing germanium-selenide glass layer comprises at least one additional silver-containing germanium-selenide glass layer.

14. A memory element of claim 13 wherein said first, said second, and said at least one additional silver-containing germanium-selenide glass layers have a stoichiometric composition of about $(Ge_xSe_{100-x})_{1-y}Ag_y$.

15. A memory element of claim 14 wherein the value of x for said at least one additional silver-containing germanium-selenide glass layer equals the value of x of any other silver-containing germanium-selenide glass layer, wherein said any other silver-containing germanium-selenide glass layer is not positioned consecutively to said at least one additional silver-containing germanium-selenide glass layer.

16. A memory element of claim 15 wherein said at least one additional silver-containing germanium-selenide glass layer comprises a third silver-containing germanium-selenide glass layer.

17. A memory element of claim 16 wherein the value of x for said first and said third silver-containing germanium-selenide glass layers is equal.

18. A memory element of claim 17 wherein the value of x for said first and said third silver-containing germanium-selenide glass layers is greater than the value of x for said second silver-containing germanium-selenide glass layer.

19. A memory element of claim 18 wherein the value of x for said first and said third silver-containing germanium-selenide glass layers is from about 38 to about 43 and the value of x for said second silver-containing germanium-selenide glass layer is from about 18 to about 33.

20. A memory element of claim 19 wherein the value of x for said first and said third silver-containing germanium-selenide glass layers is about 40 and the value of x for said second silver-containing germanium-selenide glass layer is about 25.

21. A memory element of claim 14 wherein the value of x for said at least one additional silver-containing germanium-selenide glass layer is diverse from the value of x for other silver-containing germanium-selenide glass layers.

22. A memory element of claim 15 wherein the values of x for each of said first, said second, and said at least one additional silver-containing germanium-selenide glass layer ascend from said first electrode to said second electrode.

23. A memory element of claim 15 wherein the values of x for each of said first, said second, and said at least one additional silver-containing germanium-selenide glass layer descend from said first electrode to said second electrode.

24. A memory element of claim 11 further comprising first and second electrodes respectively coupled to said first and final said at least one additional metal-containing chalcogenide glass layer wherein said first electrode comprises tungsten and said second electrode comprises silver.

25. A memory element comprising:

a first electrode comprising tungsten;

an insulating layer having an opening in communication with said first electrode;

a first silver-containing germanium-selenide glass layer formed within said opening and in communication with said first electrode, wherein said first silver-containing germanium-selenide glass layer has a stoichiometric composition represented by the formula Ge_xSe_{100-x} and x has a value of about 40.

a second silver-containing germanium-selenide glass layer formed within said opening and in communication with said first silver-containing germanium-selenide glass layer, wherein said second silver-containing germanium-selenide glass layer has a stoichiometric composition represented by the formula Ge_xSe_{100-x} and x has a value of about 25;

a third silver-containing germanium-selenide glass layer formed within said opening and in communication with a previously formed silver-containing germanium-selenide glass layer, wherein said third silver-containing germanium-selenide glass layer has a stoichiometric composition represented by the formula Ge_xSe_{100-x} and x has a value of about 40.

a second electrode comprising silver.

26. A method of fabricating a memory element comprising the acts of:

forming a first chalcogenide glass layer, said first chalcogenide glass layer having a first stoichiometry;

introducing a metal into said first chalcogenide glass layer to form a first metal-containing chalcogenide glass layer;

forming a second chalcogenide glass layer, said second chalcogenide glass layer having a second stoichiometry different from said first stoichiometry; and

introducing a metal into said second chalcogenide glass layer to form a second metal-containing chalcogenide glass layer.

27. A method of claim 26 wherein said first chalcogenide glass layer comprises a first germanium-selenide glass layer and said second chalcogenide glass layer comprises a second germanium-selenide glass layer.

28. A method of claim 27 wherein said first and said second germanium-selenide glass layers have a stoichiometric composition of about Ge_xSe_{100-x}.

29. A method of claim 28 wherein the value of x for said first germanium-selenide glass layer is greater than the value of x for said second germanium-selenide glass layer.

30. A method of claim 29 wherein the value of x for said first germanium-selenide glass layer is about 38 to about 43 and the value of x for said second germanium-selenide glass layer is about 18 to about 33.

31. A method of claim 30 wherein the value of x for said first germanium-selenide glass layer is about 40 and the value of x for said second germanium-selenide glass layer is about 25.

32. A method of claim 28 wherein the value of x for said first germanium-selenide glass layer is less than the value of x for said second germanium-selenide glass layer.

33. A method of claim 28 wherein silver is introduced into said first and said second germanium-selenide glass layers.

34. A method of claim 33 wherein the step of introducing silver into any of the said first or said second germanium-selenide glass layers having a value of x between about 18 and about 33 comprises the steps of:

depositing a silver-containing layer over said any of the said first or said second germanium-selenide glass layers having a value of x between about 18 and about 33;

irradiating said any of the said first or said second germanium-selenide glass layers having a value of x between 18 and about 33 with electromagnetic radiation of wavelength of about 200 nm to about 600 nm for approximately 5 to about 30 minutes at from about 1 mW/cm^2 to about 10 mW/cm^2.

35. A method of claim 34 further comprising removing residual silver-containing layer from over irradiated said any of the said first or said second germanium-selenide glass layers having a value of x between 18 and about 33.

36. A method of claim 34 further comprising thermally heating said silver containing layer and said first or said second germanium-selenide glass

layer at a temperature of about 50° C to about 350° C for about 5 to about 15 minutes.

37. A method of claim 36 comprising the step of thermally heating said silver containing layer and said first or said second germanium-selenide glass layer at a temperature of about 110° C.

38. A method of claim 34 wherein said silver-containing layer comprises silver-selenide.

39. A method of claim 33 wherein the step of introducing silver into any of said first of said second germanium-selenide glass layers having a value of x between about 38 and about 43 comprises the steps of:

depositing a silver-containing layer over said any of said first or said second germanium-selenide glass layers having a value of x between about 38 and about 43;

allowing silver from said silver-containing layer to migrate into said any of said first or said second germanium-selenide glass layers having a value of x of about 38 to about 43.

40. A method of claim 39 further comprising the step of removing residual silver-containing layer from over said first or said second germanium-selenide glass layer.

41. A method of claim 39 wherein said silver-containing layer comprises silver-selenide.

42. A method of claim 26 further comprising the act of forming a first electrode coupled to said first metal-containing chalcogenide glass layer.

43. The method of claim 42 wherein said first electrode comprises tungsten.

44. The method of claim 26 further comprising the act of forming a second electrode coupled to said second metal-containing chalcogenide glass layer.

45. The method of claim 44 wherein said second electrode comprises silver.

46. A method of fabricating a memory element comprising the steps of:

forming a first chalcogenide glass layer, said first chalcogenide glass layer having a first glass matrix structure;

introducing metal into said first chalcogenide glass layer to form a first metal-containing chalcogenide glass layer;

forming a second chalcogenide glass layer, said second chalcogenide glass layer having a second glass matrix structure diverse from said first glass matrix structure;

introducing metal into said second chalcogenide glass layer to form a second metal-containing chalcogenide glass layer;

forming at least one additional chalcogenide glass layer, said at least one additional chalcogenide glass layer having a glass matrix structure different from the glass matrix structure of any metal-containing chalcogenide glass layer adjacent to said at least one additional metal-containing chalcogenide glass layer; and

introducing metal into said at least one additional chalcogenide glass layer to form at least one additional metal-containing chalcogenide glass layer.

47. A method of claim 46 wherein said first chalcogenide glass layer comprises a first germanium-selenide glass layer, said second chalcogenide glass layer comprises a second germanium-selenide glass layer, and said at least one additional chalcogenide glass layer comprises at least one additional germanium-selenide glass layer.

48. A method of claim 47 wherein said first, said second, and said at least one additional germanium-selenide glass layers have a stoichiometric composition of about Ge_xSe_{100-x}.

49. A method according to claim 48 wherein the value of x for said at least one additional germanium-selenide glass layer equals the value of x of any other germanium-selenide glass layer, wherein said any other germanium-selenide glass layer is not positioned consecutively to said at least one additional germanium-selenide glass layer.

50. A method of claim 49 wherein said at least one additional germanium-selenide glass layer comprises a third germanium-selenide glass layer.

51. A method of claim 50 wherein the value of x for said first and said third germanium-selenide glass layers is equal.

52. A method of claim 51 wherein the value of x for said first and said third germanium-selenide glass layers is greater than the value of x for said second germanium-selenide glass layer.

53. A method of claim 52 wherein the value of x for said first and said third germanium-selenide glass layers is from about 38 to about 43 and the value of x for said second germanium-selenide glass layer is from about 18 to about 33.

54. A method of claim 53 wherein the value of x for said first and said third germanium-selenide glass layers is about 40 and the value of x for said second germanium-selenide glass layer is about 25.

55. A method of claim 48 wherein the value of x for said at least one additional germanium-selenide glass layer is diverse from the value of x for other silver-containing germanium-selenide glass layers.

56. A method of claim 55 wherein the values of x for each of said first, said second, and said at least one additional germanium-selenide glass layer ascend from said first electrode to said second electrode.

57. A method of claim 55 wherein the values of x for each of said first, said second, and said at least one additional germanium-selenide glass layer descend from said first electrode to said second electrode.

58. A method of claim 48 wherein said metal comprises silver.

59. A method of claim 58 wherein the step of introducing silver into any of the said first, said second, or said at least one additional germanium-selenide glass layers having a value of x between about 18 and about 33 comprises the steps of:

depositing a silver-containing layer over said any of the said first, said second, or said at least one additional germanium-selenide glass layers having a value of x between about 18 and about 33;

irradiating said any of the said first, said second, or said at least one additional germanium-selenide glass layers having a value of x between about 18 and about 33 with electromagnetic radiation of wavelength of about 200 nm to about 600 nm for approximately 5 to about 30 minutes at from about 1 mW/cm^2 to about 10 mW/cm^2.

60. A method of claim 59 further comprising removing residual silver-containing layer from over irradiated said any of the said first, said second, or said at least one additional germanium-selenide glass layers having a value of x between about 18 and about 33.

61. A method of claim 59 further comprising thermally heating said silver containing layer and said any of the said first, said second, or said at least one additional germanium-selenide glass layers having a value of x between about 18 and about 33 at a temperature of about 50° C to about 350° C for about 5 to about 15 minutes.

62. A method of claim 61 comprising the step of thermally heating said silver containing layer and said any of said first, said second, or said at least one additional germanium-selenide glass layer having a value of x between about 18 and about 33 at a temperature of about 110° C.

63. A method of claim 59 wherein said silver-containing layer comprises silver-selenide.

64. A method of claim 58 wherein the step of introducing silver into any of the said first, said second, or said at least one additional germanium-selenide glass layers having a value of x between about 38 and about 43 comprises the steps of:

depositing a silver-containing layer over said any of the said first, said second, or said at least one additional germanium-selenide glass layer having a value of x between about 38 and about 43;

allowing silver from said silver-containing layer to migrate into said any of said first, said second, or said at least one additional germanium-selenide glass layer having a value of x between about 38 and about 43.

65. A method of claim 64 further comprising the step of removing residual silver-containing layer from over said any of said first, said second, or said at least one additional germanium-selenide glass layer having a value of x between about 38 and about 43.

66. A method of claim 64 wherein said silver-containing layer comprises silver-selenide.

67. A method of claim 46 further comprising the step of forming a first electrode coupled to said first metal-containing chalcogenide glass layer.

68. A method of claim 67 wherein said first electrode comprises tungsten.

69. A method of claim 46 further comprising the step of forming a second electrode coupled to the last formed said at least one additional metal-containing chalcogenide glass layer

70. A method of claim 69 wherein said second electrode comprises silver.